Resistive Heating for DNAPL Removal

A Feasibility Study for Vaporizing Contaminants in the Saturated Zone

THE NEED

Effective methods are needed to treat dense solvents (e.g., TCE, PCE, 1,1,1-TCA, methylene chloride, etc.) which accumulate in aquifers as pools of solvent or immobile residual. These can slowly diffuse into the groundwater, creating long-term sources of contamination. This is particularly important to the Air Force, as dense solvents are present at more than one third of Air Force contaminated sites. Currently, there are no acceptable, cost-effective methods for removing or treating the bulk solvent material. Efforts to remove solvents by groundwater extraction are modestly effective at remediating the contaminant plume but would take decades to remove significant portions of the contaminant source.

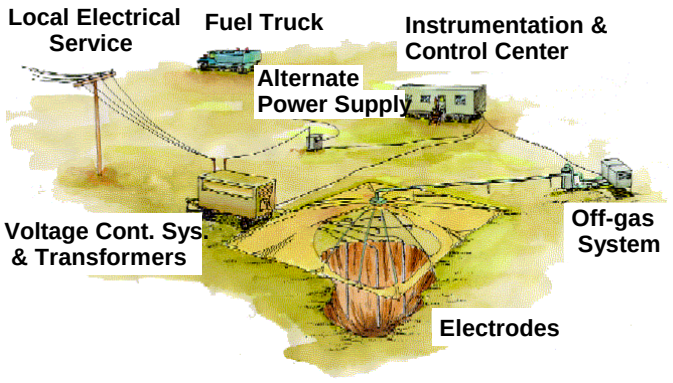

Fig 1. Six-Phase Soil Heating

THE OBJECTIVES

This field effort demonstrated six-phase soil heating (SPSH) technology with the potential for cleaning up dense, nonaqueous phase liquids (DNAPLs) from contaminated aquifers. This technology treats DNAPL source zones and avoids the long-term costs associated with pump-and-treat containment of contaminated groundwater.

THE TECHNOLOGY

SPSH uses common power line frequency (60 Hz) to heat soils and groundwater. Electrodes are installed in the region to be treated and a voltage is applied (See Fig. 1). Enhancement occurs by heating and holding the subsurface temperature at the boiling point of soil moisture while continuously removing volatilized contaminants through venting. SPSH also creates an in situ source of steam to strip contaminants from soils and groundwater. The process results in accelerated and more complete removal of target contaminants from soil, as compared to conventional soil vapor extraction.

Because the mode of heating is electrical conduction through soil moisture, SPSH tends to heat the entire treatment region, including low-permeability soil lenses where DNAPLs may reside. By comparison, injected air or steam tends to rise rapidly or follow higher permeable pathways, leaving many regions relatively untreated.

FIELD DEMONSTRATIONS

This project investigated the potential of SPSH to remove contaminants from the saturated zone. Battelle Memorial Institute demonstrated SPSH on a saturated, clean site at the Dover National Test Site (DNTS), National Environmental Technology Test Site (NETTS), Dover Air Force Base (AFB), Delaware, in January 1997. The DNTS is a major technology test bed of the Strategic Environmental Research and Development Program (SERDP)/ NETTS. Two tracer compounds with physical properties similar to common Air Force contaminants (i.e., TCE and PCE) were injected into the groundwater. Groundwater, soil vapor, and off-gas samples were collected and analyzed to demonstrate control and collection of contaminants. During normal heating operations, subsurface thermocouples closely monitored the progress of soil heating. Phase voltages were controlled to ensure uniform heating across the treatment zone.

The two-month field demonstration proved that it was both feasible and cost-effective to operate SPSH systems under saturated conditions. SPSH was later used for hot-spot treatment of a saturated TCE-contaminated site at Ft Richardson, Arkansas, with a contaminant removal efficiency of approximately 95 percent.

THE PLAYERS

Maj Paul Devane is the program manager for this effort for the US Air Force Research Laboratory, Materials and Manufacturing Directorate, Airbase and Environmental Technology Division (AFRL/MLQ). The technology was developed by Battelle Pacific Northwest National Laboratory under the leadership of Ms. Theresa Bergsman. SPSH has been commercialized by Current Environmental Solutions, LLC, Richland, Washington.

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